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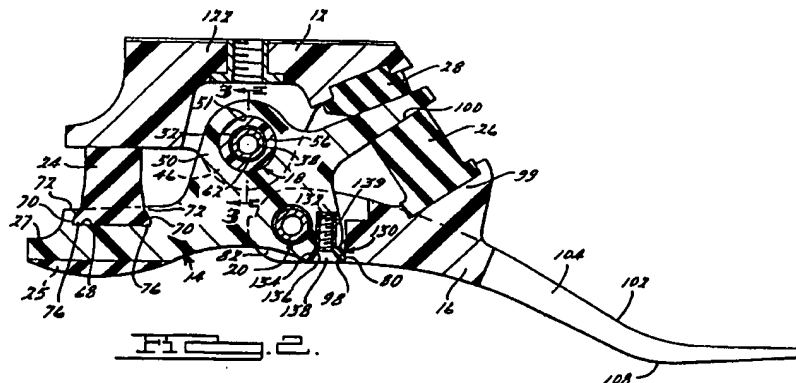
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This application was filed on 27 - 05 - 1999 as a
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(54) An artificial foot

(57) An artificial foot comprises an ankle member (12), a heel member (14) and a toe member (16) pivotably connected together. The toe member is formed with an elongated slot (104) therethrough extending longitudinally rearwardly from a forward end of the toe member and bifurcating the toe member into two symmetrically positioned and substantially mirror imaged toe sections (102) that diverge in separate generally anterior directions from a pivotable connection (20) of

the toe member to the heel member with a weight supporting section (108) at each toe section. The pivotable connection (20) for resiliently resisted pivotal movement is about a transverse axle. The heel member and the toe member each has a central abutment shoulder (80, 98) that abut each other to define an end limit to downward pivotable movement of a forward section of the toe member with respect to the heel member.



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Description

TECHNICAL FIELD

[0001] This invention relates to prosthetic feet and more particularly to a multi-piece prosthetic foot having an ankle member, heel member and toe member.

Background of the Invention

[0002] The basic requirements of an acceptable prosthetic foot are that it will provide a stable support for the amputee throughout a reasonable range of activities and permit the amputee to walk with a normal stride. To achieve this normal stride, the prosthetic foot must mimic the movement of an anatomic foot during walking as the foot continually moves through the heel-strike foot-flat and toe-off cycle. It must also throughout this cycle, provide transverse stability particularly at the toe-off, when the entire weight of the amputee is applied to the forward portion of the prosthetic foot. Prior art prosthetic feet typically are substantially transversely inflexible, which interferes with side to side balancing when walking on uneven surfaces. Unlike a natural foot, the prosthetic foot does not sense or correct itself with this unevenness and an unanticipated sideways tilting of the foot at toe-off results in an imbalance at a critical portion of the stride.

[0003] Amputees are no longer satisfied to sit in a wheel chair or be content with a stilted walking motion. An amputee often strives to duplicate physical activities which were conducted before the amputation. These activities may include rigorous physical activities such as running, playing basketball and dancing. Consequently, the artificial foot must also be adaptable to be worn with different styles of shoes.

[0004] Prosthetic feet to be commercially acceptable must duplicate the motions of the natural foot as much as possible. these motions include side to side stability at the toe section of the foot where weight can be exerted on each side of the foot. The ankle joint must have torsional flexibility transverse to the up and down motion of the ankle which pivotally lowers and raises the foot.

[0005] The added torsional motion of the joint in the artificial foot adds a degree of stress on the resilient pads between the members of the artificial foot not otherwise present in a foot that has limited motion in only the up and down direction relative to pivotable raising and lowering of the foot.

[0006] The torsional flexing must be limited within an anatomic range of motion and must be direction sensitive to provide a more lifelike ankle action. Secondly, the resilient pad between the member of the feet must be positively anchored to resist being displaced during torsional motion of the ankle joint.

[0007] It is further required to have a commercially viable foot that has a formed symmetrical toe member that

is used for both left and right feet so that inventory is reduced. The toe member must be shearable to conform to the desired size and to fit within an appropriate left or right shoe.

[0008] What is also needed is an ankle member that can be secured to a variety of wedges interposed between the artificial leg and foot such that the artificial foot can be used with high heels or other shoes with varying heel heights.

Summary of the Invention

[0009] In accordance with one aspect of the invention, a prosthetic foot has an ankle member pivotally connected to a heel member which is in turn pivotally connected to a toe member about two substantially parallel axes. The toe member is symmetrically formed with an elongated slot starting at the forward end of the toe member bifurcating the toe section into two symmetrically positioned and mirror imaged toe sections.

[0010] In accordance with another aspect of the invention, the ankle axle passes through two spaced resilient bushings that are positioned in an aperture transversely extending through the heel member. The ankle member has two shoulder sections with apertures therethrough that are aligned with the aperture through the heel member to form a passage for the axle. Interposed between the two elastomeric bushings is a semi-rigid bearing with an outer diameter sized to be snugly and slidably received in the central aperture of the heel. The bearing has an inner diameter sized slightly larger than the outer diameter of the axle to provide for limited transverse motion of the axle within the aperture. The inner diameter provides for an axle stop after a predetermined amount of resilient deformation of the bushings.

[0011] In accordance with another aspect of the invention, the ankle joint includes one of the heel and ankle members having a stop limit. The stop limit includes first and second oppositely canted abutment surfaces circumferentially positioned about the passage receiving the axle and constructed to abut complementary abutments on the other of the heel and ankle member to limit pivotable motion transverse to the longitudinal axis of the axle. In one embodiment, the canted abutments are annular flat shoulders canted with respect to the longitudinal axis of the axle. Transverse pivotable motion about the central axis along the first direction is provided for a first predetermined amount and transverse pivotable motion about a second direction is provided for a second different predetermined amount before the abutments stop the pivotable motion.

[0012] According to another aspect of the invention, the axles connecting the heel member to one of the toe members and ankle member includes an integrally formed pin with an integral stop shoulder for engagement to a side of the foot. The integrally formed pin passes through both the heel member and one of the

ankle and toe members. The pin by passing through the entire passage formed by the heel and one of the toe and ankle members provides for increased strength and durability of the axle joint formed with the pin.

[0013] One end of the axle has a recessed tool engaging mechanism for non-rotatably engaging a tool at said one end. The opposite end of the axle pin has a fastener engaging section for connection to a fastener. The fastener has a stop shoulder for engagement to another side of the foot about the end of the passage. The fastener has a tool engaging mechanism wherein the axle can be tightened such that the stop shoulders snugly abut against the sides of the foot.

[0014] In accordance with another aspect of the invention, an assembly tool has a axle engaging section for engaging the fastener receiving section of the axle pin and a cylindrical section for insertion into the apertures of the respective toe, heel and ankle members and a handle section for gripping the tool. A stop shoulder is interposed between the handle section and cylindrical section for providing a stop against a side of the foot for when the tool is inserted into the apertures and when the pin has fully been extended out of the apertures.

[0015] In accordance with another aspect of the invention, the ankle member is adaptable to be mounted to either an endoskeletal leg member or exoskeletal leg member. The ankle member has a threaded passage-way therethrough which receives a threaded fitting. A threaded fitting has an oppositely threaded interior aperture which engages a downwardly extending fastener from an endoskeleton. Removal of the insert allows for an upwardly extending fastener to pass through the aperture to engage an exoskeleton.

[0016] In one preferred embodiment, the ankle member may have a slot at its top portion thereon with a recessed seat for pivotably seating a fastener head. The fastener extends through the slot. A wedge having a hole therethrough that is sized to pass the fastener therethrough is interposed between the ankle and the leg such that the bottom surface of the wedge is angled with respect to the top surface thereof. The wedge and ankle member have complementary dove tail and slots extending along the length of the foot to allow the two parts to slidably connect to each other without relative rotation. The foot is thus mounted at an angle with respect to the leg to accommodate shoes with different heel heights. With different angled wedges, the foot can be mounted at different angles with respect to the leg. The wedge allows for the foot to be used with high heel shoes and other shoes with varying heel heights.

[0017] According to another aspect of the invention, at least one of the resilient bumpers interposed between two of the foot members is positively anchored in place by means of a recess in one of the foot members having a lip extending over the recess which positively engages the resilient elastomeric pad. Preferably, the elastomeric pad has an ear extending at one end which extends into the recess.

[0018] In this fashion, a foot having fewer number of inventory parts can be assembled to accommodate high heels and other shoes of different heel heights and provide a torsionally resilient ankle that allows torsional flexing of the foot within limits that are dependent on the relative pivotal position of the heel with respect to the ankle member about the ankle joint. Furthermore the bifurcated toe provides for side to side stability. The symmetrical shape of the formed toe member allows for one toe member to be used for either left or right prosthetic feet. One of the toe members can be cut to allow for confirmation of the small toe side to accommodate smaller sized shoes and feet sizes. In addition, positively anchored elastomeric members are maintained in position in the foot to provide for a stable member against torsional motion of one foot member with respect to another.

Brief Description of the Drawings

[0019] Reference now is made to the accompanying drawings in which:

FIGURE 1 is a perspective view of a prosthetic foot skeletal structure embodying the present invention; FIGURE 2 is a cross sectional view taken along the lines 2-2 in Figure 1;

FIGURE 3 is a fragmentary cross sectional view taken along the lines 3-3 shown in Figure 2;

FIGURE 4 is a perspective view of the heel member shown in Figure 1;

FIGURE 5 is a top plan view of the toe member shown in Figure 1;

FIGURE 6 is a perspective view of the rear elastomeric pad shown in Figure 1;

FIGURE 7 is a view of the heel toe axle connection partially disassembled for engagement to an assembly and disassembly tool;

FIGURE 8 is a view similar to Figure 7 showing the tool pushing out the axle for disassembly;

FIGURE 9 is a view showing the ankle member mounted to an endoskeleton leg portion

FIGURE 10 is a fragmentary view showing the modified ankle member mounted to an exoskeleton leg portion;

FIGURE 11 is an exploded view illustrating another embodiment of an ankle member and an adjustment wedge;

FIGURE 12 is a fragmentary segmented view showing a prosthetic foot with the ankle and wedge member illustrated in Figure 11 mounted to a prosthetic leg to accommodate high heel shoes; and

FIGURE 13 is a cross sectional view taken along lines 13-13 shown in Figure 12.

Detailed Description of the Preferred Embodiments

[0020] Referring to Figures 1 and, a prosthetic foot 10

has an ankle member 12, a heel member 14 and toe member 16. The ankle member 12 is pivotably connected to heel member 14 through ankle joint 18. The heel member 14 is pivotably connected to toe member 16 through axle joint 20. The heel, ankle, and toe members are made from a suitable synthetic thermoplastic or composite material such as graphite that can be fiberglass reinforced. The axle joints 18 and 20 provide for pivotable motion of the three members along the axis of the axle joints which runs transverse to the longitudinal axis of the foot; i.e., the length of the foot. Furthermore as explained below, the axle joint 18 provides for limited torsional or pivotable motion about a direction transverse to the longitudinal axis of the axle 18.

[0021] Elastomeric pad 24 provides for resilient resistance of heel member with respect to ankle member 12 against clockwise motion as referenced in Figure 2. Elastomeric pad 26 resists upward counterclockwise motion of toe member 16 with respect to the heel member 14 and elastomeric pad 28 resists clockwise motion of the heel member with respect to heel member 14 and elastomeric pad 28 resists clockwise motion of the heel member with respect to the ankle member. The pads 24, 26, 28 can be selected by size and durometer to accommodate different people's weight, size and personal preferences. A heel pad 25 is bonded to the rear lower section 27 to also absorb shock and vibration. As shown in phantom in Figure 11 when assembled, the elastomeric pad and foot members 12, 14, and 16 can be covered by a firm resilient elastomeric outer layer 30 whose outer surface is cosmetically conformed to that of a natural foot.

[0022] Referring now to Figures 2 and 3 the axle joint 18 includes an axle or pin 32 which has one end having an abutment shoulder 34 sized to abut one side 43 of the member 12. The end 35 has a cavity 36 therein which is conformed to non-rotatably receive a tool such as an allen wrench. The pin 32 has a cylindrical section 38 and a second end 39 with an internally threaded section 41 axially positioned within cylindrical section 38. Section 41 receives a threaded fastener 40. The fastener 40 also has a tool receiving cavity or recess 42 therein that can receive an allen wrench or a screwdriver. The fastener 40 also has a tool receiving cavity or recess 42 therein that can receive an allen wrench or a screwdriver. The fastener 40 may include a washer 44 sized to abut another side 43 of ankle member 12.

[0023] The ankle member 12 has two flange sections 46, each with an aperture 48 that receives the pin 32. The flanges 46 are spaced apart to receive the central section 50 of heel member 14. The central section 50 has an aperture 51 which is significantly larger than the outer diameter of pin cylindrical section 38. The pin 32 is integrally formed and extends through both apertures 48 and aperture 51. Because the flange members 46 bear down on the one-piece pin 32 that extends through and beyond aperture 51, a durable and strong axle is formed at joint 18. Two rubber or resilient elastomeric

bushings 52 have an outer diameter 53 sized to be snugly received in aperture 51 and have an inner diameter 54 sized to snugly receive the cylindrical portion 38 of pin 32. Axially interposed between the bushing 52 is a semi-rigid plastic bushing 56 made from Delrin having an outer diameter 58 sized to be slidably snugly received in aperture 51. The bushing 52 has an inner diameter 60 which is sized larger than the outer diameter of cylindrical section 38 to provide for an annular gap 62 therebetween. The mounting section 50 has tapered sidewalls 64 which are oppositely angled with respect to each other on opposite sides of aperture 50 and are slightly spaced from inner walls 66 of flanges 46.

[0024] The bushings 52 provide for both translational motion of the ankle member with respect to the heel member and torsional or pivotal motion which is transverse to the longitudinal axis of pin 32 when in the rest position. The bushings 52 can be selected by durometer to resiliently resist translational and torsional motion of the ankle member with respect to the heel member depending on a person's weight, size and personal preference. However the translational motion is limited by the inner diameter 60 of bushing 56 such that upon translational motion of a predetermined amount, the pin cylindrical section 38 abuts the internal diameter 60 of the bushing 56 which resists further translational motion. Pivoting motion of the pin 32 is limited by the tapered shoulder 64 abutting the interior walls 66 of flanges 46. Because the walls 64 are tapered in a direction as shown in Figure 4, when the ankle is pivoted either clockwise or counterclockwise from the position shown in Figure 2, the amount of torsional pivoting between the ankle and heel member will differ. In other words different amounts of torsional motion may be allowed at different relative positions of the ankle member with respect to the heel member. Less torsional flexibility may be provided when the elastomeric bumper 24 is significantly compressed such that the heel is rotated clockwise with respect to the ankle member 12. This different torsional motion dependent upon the position of the ankle more realistically imitates a natural ankle at its varying elevated positions.

[0025] Because torsional motion may exert a sideways pulling force on elastomeric pad 24, elastomeric pad 24 needs to be positively engaged within the heel member. This is accomplished by a cavity 68 having a recess 70. The heel member has a lip 72 extending over the recess 70 to positively engage the elastomeric pad 24. As shown in Figure 6, the elastomeric pad 24 has a substantially oval lower section 74 with a substantially longer side 75 of the oval section each having a protruding ear 76 which can be received in recess 70.

[0026] Referring now to Figures 4, 5, 7 and 8, the axle joint 20 between the heel member 14 and toe member 16 provides pivoting motion of the toe in an up and down direction. The heel member 14 has a central aperture 78 at a lower section in proximity to an abutment shoulder 80. The toe member has two flanges 82 with aper-

tures 84 therethrough that are aligned with respect to each other. The flanges 82 are spaced apart to receive the lower section 79 of heel member 14. The apertures 78 and 84 are aligned to snugly and slidably receive an integrally formed pin 86. Aperture 78 has two counter bores 81 sized to receive two resilient bushings 83 of desired durometer. The bushings 83 function in a similar fashion to bushings 52 to resiliently resist torsional and translational motion of the toe member relative to the heel member. The center section 85 of aperture 78 functions as a limit stop. The center section forms an annular gap 87 therebetween.

[0027] Pin 86 is similarly constructed to pin 32 with a flange end 88 having a recess 89 adapted to non-rotatably receive a tool such as an allen wrench. A second end 90 has a threaded cavity 91 adapted to receive either a fastener 40 or a tool 92 as shown in Figures 7 and 8. The pin 86 extends through both flanges 82 of toe member 16 and heel member 14. The tool 92 has a threaded section 93 engagable to threaded section 91 of cylindrical section 94 and hand gripping section 96. A stop shoulder 95 is interposed between the hand gripping section 96 and cylindrical section 94. The stop shoulder 95 can be integral or be a separate clip member 97 engaged in a groove 99. Cylindrical section 94 has an outer diameter equal to the outer diameter of pin 86 that passes through apertures 84 and 78. The assembly of either axle 18 or 20 is expedited with the use of tool 92.

[0028] The tool as shown in Figure 7 can be engaged with the threaded section 91. The tool is pushed by force exerted on handle section 96 to slide the pin outwardly. The section 92 passes through the apertures 84 and 78 until the stop shoulder 95 abuts the flange 82 as shown in Figure 8. At this time the pin 86 can be unthreaded from section 93. The hand grip then is pulled back such that section 94 is withdrawn from the apertures 84 and 78 to disassemble the axle joint 18. Assembly of the axle joint 18 is achieved by reversing the steps. The pin tool 92 is inserted into the axle apertures. The pin 86 is then threaded onto the section 93 and the handle section 96 is pulled thereby pulling the pin 92 into the apertures. Fastener 40 is then threaded onto pin 32.

[0029] A similar process is also used for axle joint 20. The toe section between flanges 82 has an abutment shoulder 98 which abuts the abutment shoulder 80 of heel member 14 to provide for a limit stop in the downward motion of toe member 16 relative to the heel member 14. The toe member has mounting section 99 which receives elastomeric pad which abuts flange section 100 of heel member 14. The elastomeric pad 26 provides resilient resistance against the upward pivotal motion of toe member 16 relative to the heel member 14. The toe member 16 has two symmetrically positioned and mirror image toes 102 with a bifurcating slot 104 therebetween which extends from the front distal ends 106 of toes 102. Each toe has a ball support sec-

tion 108 which supports weight at the rest position.

[0030] The shoulder 80 is on a metal insert member 130 that is fitted in a notch 132 in heel member 14. The member 130 has a rear inclined surface 134 that abuts inclined surface 136 of heel member 14. The member 130 has an aperture 136 therethrough that receives screw 138 that engages threads 139 in heel member 14.

[0031] After the pin 86 is installed in ankle joint 20, the pad 26 can be preloaded by installing the metal insert member 130. As the screw 138 is tightened, the inclined surfaces 134 and 136 force the member 130 forward to abut shoulder 98 and thereby pivot the toe member 16 in a counter-clockwise direction as shown in Figure 2 which places a preload on pad 26.

[0032] The preloading of pad 26 improves its wear and durability. The elastomeric pad 26 is preferably compressed to its compression set point. When such preloading of pad 26 occurs, the toe member 16 remains loaded against insert member 130 and any undesirable loosening of the toe member with respect to the heel member 14 is eliminated. Readjustment of the toe member with the heel member becomes unnecessary. The preloading also changes the feel of the foot. The preloaded pad 26 feels like a larger pad that is not under a preload. As such a stiffer foot is possible without increasing the size of the components.

[0033] The metal insert member 130 also allows repair or replacement of elastomeric pad 26 without the need to disassemble axle 20. When the insert member 130 may be disassembled from heel member 14. Toe member 16 is then free to pivot clockwise as shown in Figure 2 displacing pad 26 to an accessible position. The pad 26 now spaced from flange section 100 may be repaired or replaced.

[0034] As shown in Figure 5, the symmetry of the toes 102 allows for one toe member 16 to be manufactured for both left and right feet. If a particular foot size is small, for contour purposes the outer or small toes need to be shortened. This contour can be easily accomplished by cutting one of the toes 102 for example along one of the dotted lines 110 to provide for a shorter outer toe which would fit within a smaller cosmetic outer foot cover and a smaller sized shoe. However for standard and larger feet, the toes 102 need no trimming. The ball or weight bearing sections 108 are independently flexible such that one toe 102 can be flexed and change its height relative to the vertical position of the other toe.

[0035] The ankle member 12 is adaptable to be attached to either an endoskeleton as shown in Figure 9 or an exoskeleton as shown in Figure 10. The ankle member has longitudinal slots 112 and 114 which non-rotatably engage standard attachments such as Otto Bock endoskeletal and exoskeletal systems and/or adapters. The endoskeletal and exoskeletal systems as shown in Figures 9 and 10 are standard and form no part of the invention. The ankle member 12, however, is adaptable to be connected to either system. The ankle

member 12 can be connected to an exoskeletal connection 118 as shown in Figure 10. A bolt 130 having an enlarged head 132 passes upward through the aperture 121 with the bolt head engaging the recessed flange 131 of ankle member 14. The threaded portion 133 of the bolt then engages the endoskeleton fastener 135.

[0036] For attachment to an endoskeleton as shown in Figure 9, a top portion 122 of the ankle 12 has the aperture 120 resized. Threaded insert 118 self taps in aperture 120. The threaded insert 118 has an interior opposite threaded aperture 124. A bolt 127 extends through the endoskeletal adaptor 126 and threadably engages threaded aperture 124.

[0037] Referring to Figures 11, 12 and 13, the prosthetic foot 10 has a modified member 12a connected to an adjustment attachment mechanism 140 to compensate for shoes 142 having high heels 144 or different heel heights. As shown in Figure 11, the lower surface 156 of member 154 has a dove tail 160 to engage a dove tail slot 162 longitudinally extending along the upper surface 164 of the ankle member 12a. The ankle member 12a has a slot 146 with a contoured seat section 150. The seat section 150 engages a semi spherically contoured bolt head 151. The bolt 153 passes through the slot 146 and through an aperture 152 of a wedge member 154 to engage attachment mechanism 118 of exoskeleton shown in Figure 10. The aperture 152 has its axis perpendicular to its upper surface 155 and that the wedge member 154 is fixed positioned on ankle member 12. The upper surface 155 may have longitudinal 166 grooves to non-rotatably engage the leg member. The foot when at the rest position is downwardly extended relative to the foot shown in Figure 2. Different wedge member 154 having different degrees of angles between the surfaces 155 and 156 can accommodate for different shoe heel heights. The slot 146 provides for the bolt 153 passing through the ankle member 12 at different angles. The seat 150 is spherical in shape to provide for flush seating of the complementary semi-spherical shaped bolt head 151 at the various angles. The dove tail slot 162 and dove tail 160 prevent the ankle member and wedge member from relative rotation. The ankle joint 18 is aligned vertically below the bolt 153 and slot.

[0038] Variations and modifications of the present invention are possible without departing from its scope and spirit as defined by the appended claims.

Claims

1. An artificial foot, comprising

an ankle member (12), a heel member (14) and a toe member (16) pivotably connected together,

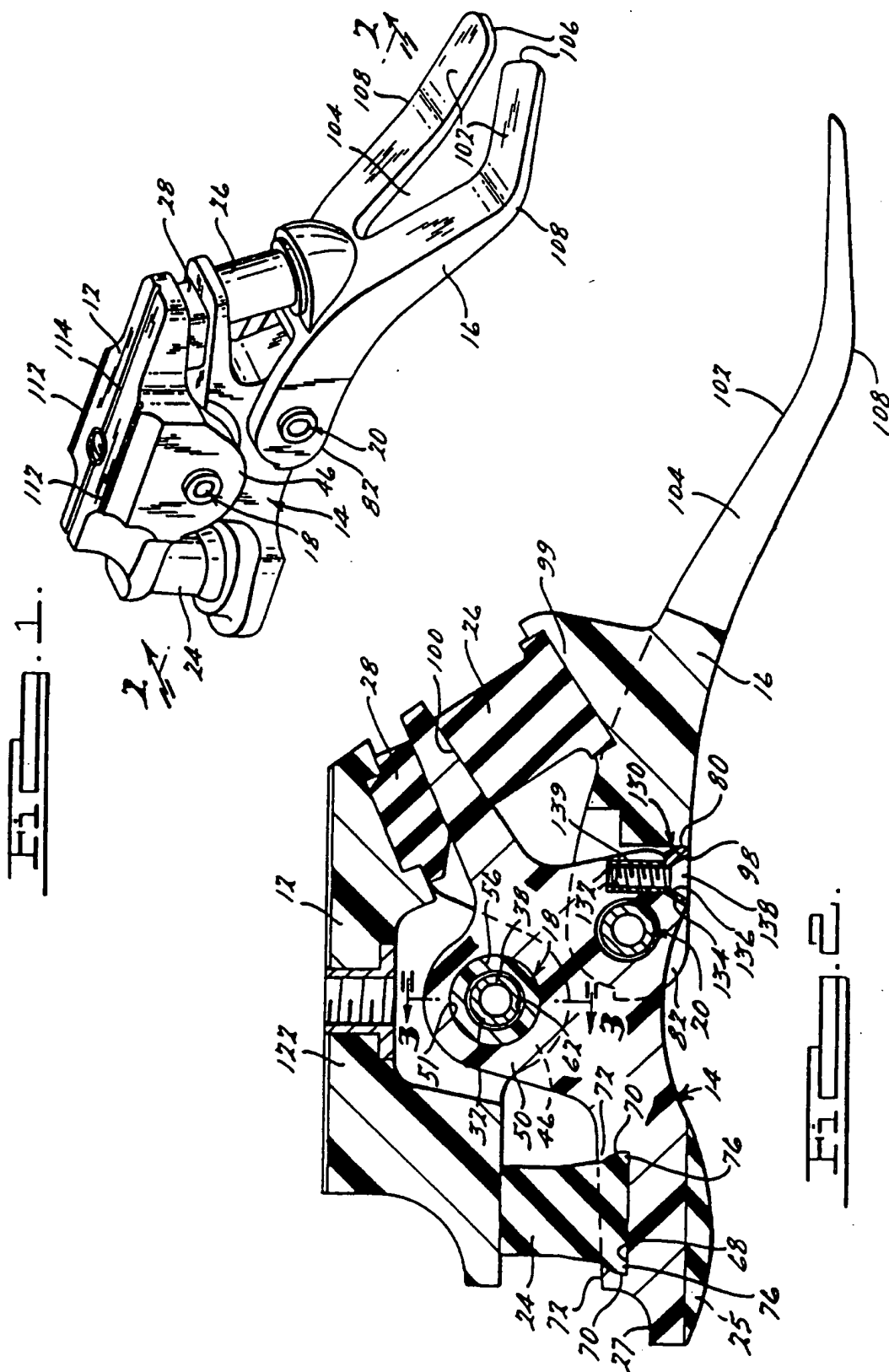
said toe member (16) being formed with an elongated slot (104) therethrough extending longitudinally rearwardly from a forward end of

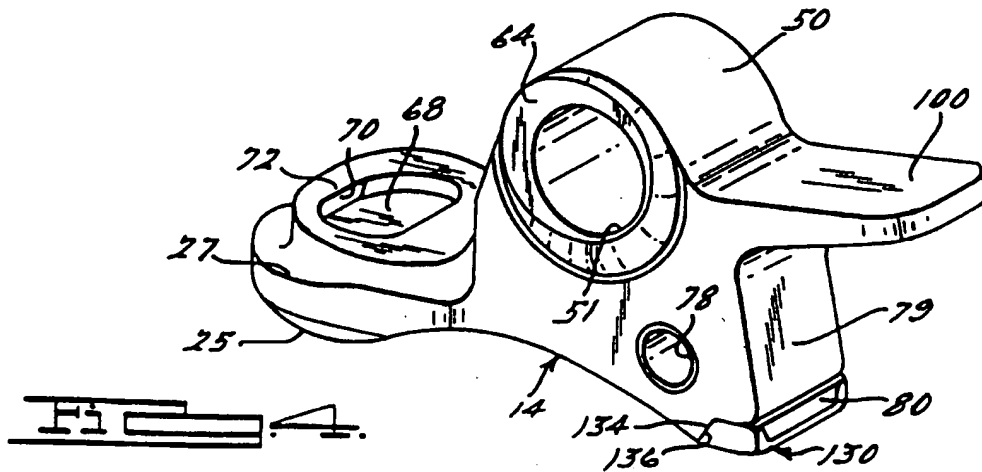
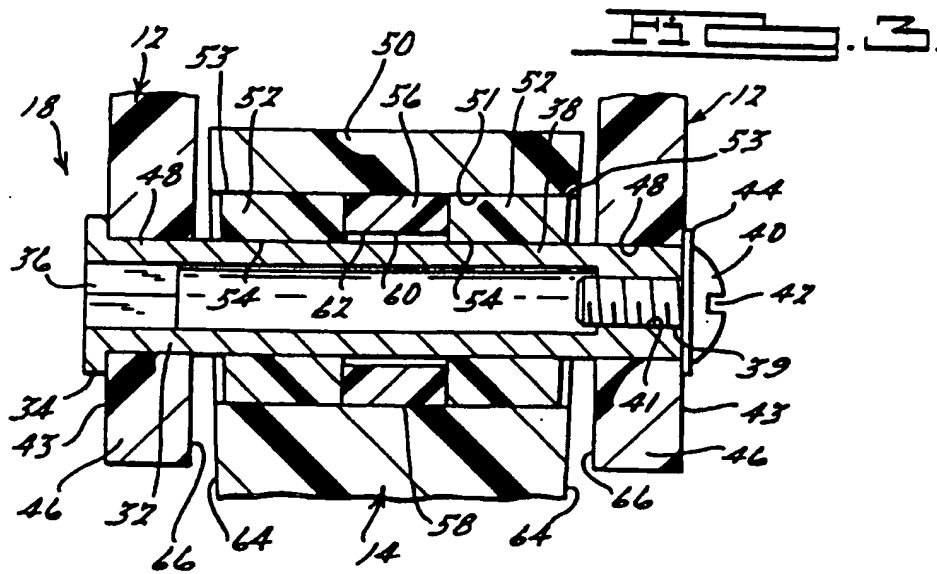
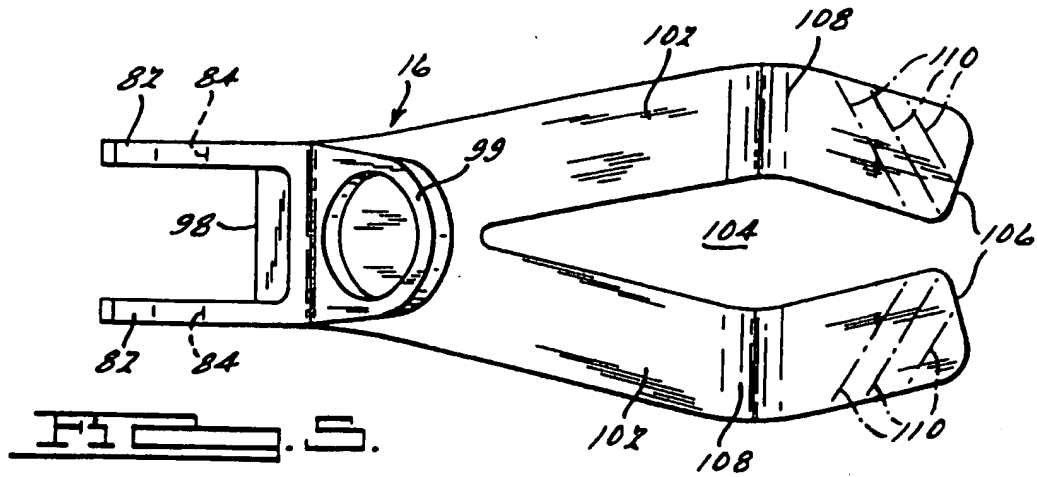
said toe member (16) and bifurcating said toe member (16) into two symmetrically positioned and substantially mirror imaged toe sections (102) that diverge in separate generally anterior directions from a pivotable connection (20) of said toe member (16) to said heel member (14) with a weight supporting section (108) at each toe section (102),

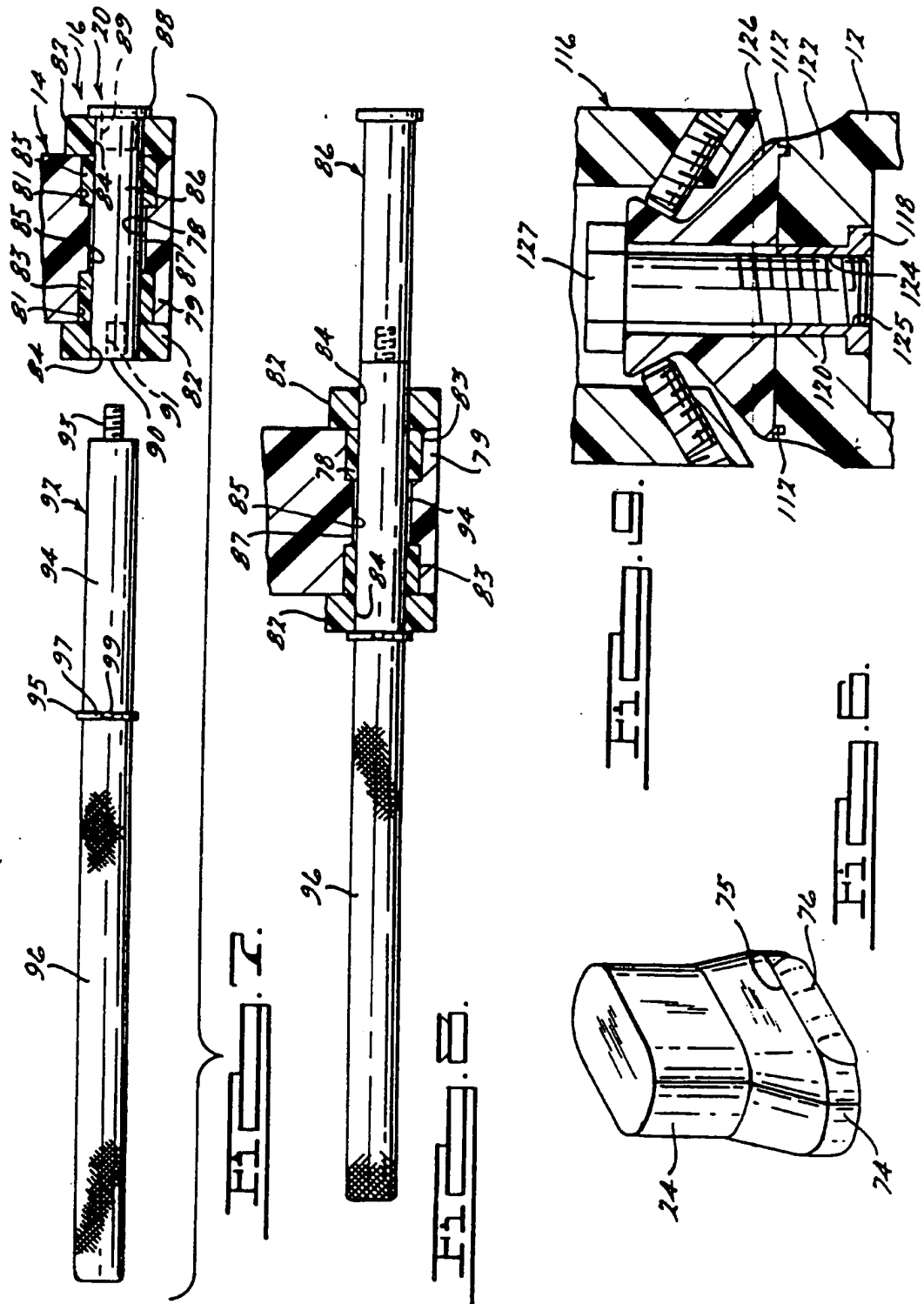
said pivotable connection (20) between said heel member (14) and said toe member (16) for resiliently resisted pivotal movement being about a transverse axle,

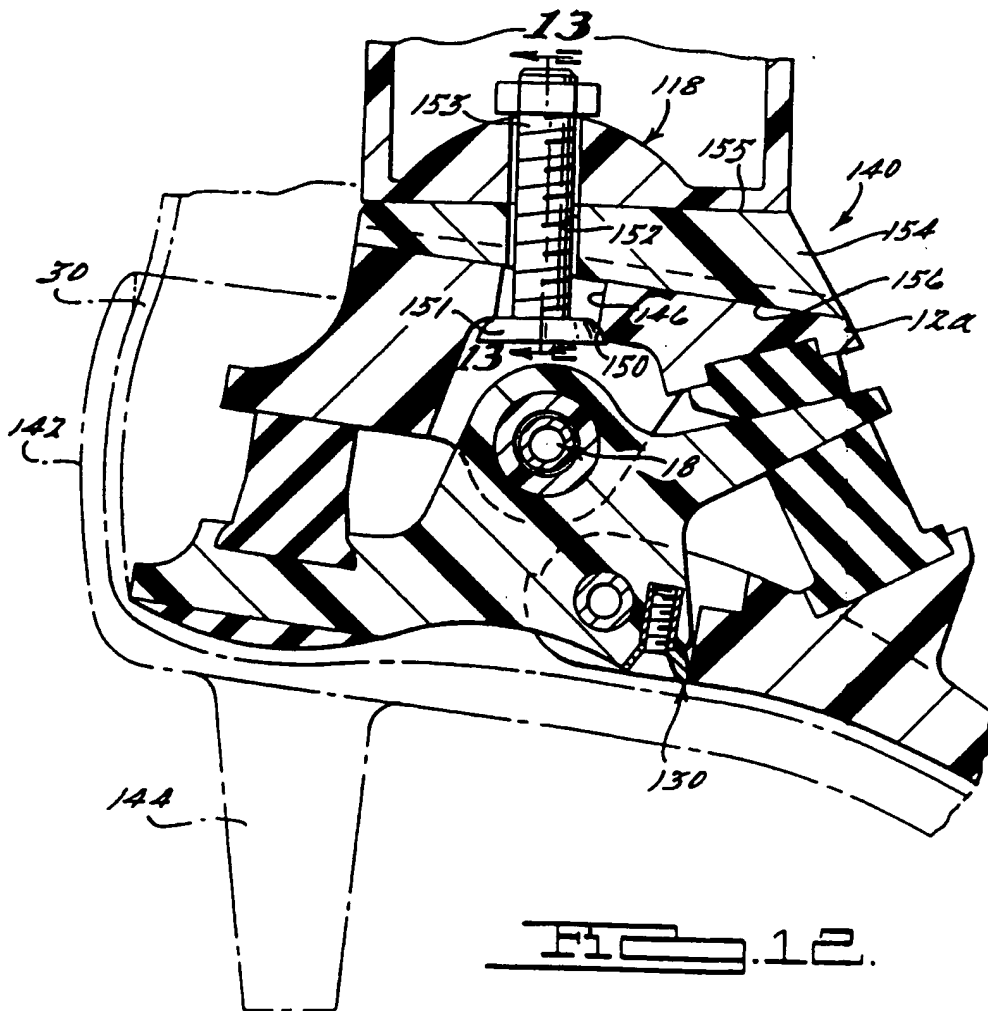
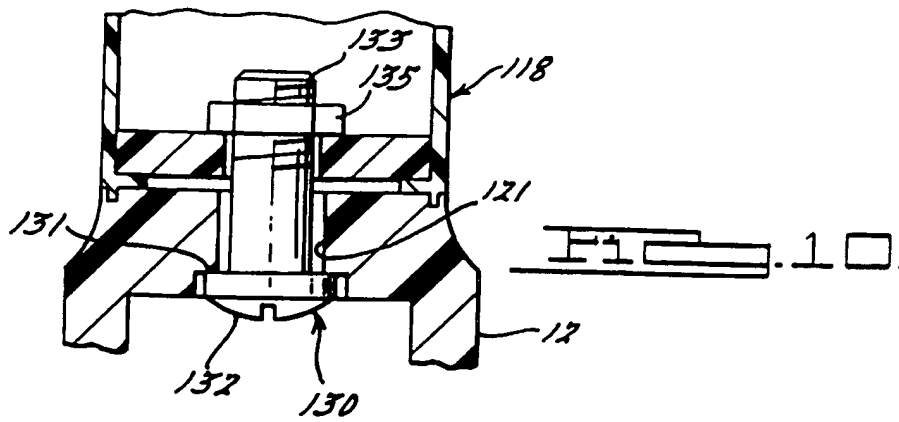
said heel member (14) and said toe member (16) each having a central abutment shoulder (80, 98) that abut each other to define an end limit to downward pivotable movement of a forward section of said toe member (16) with respect to said heel member (14).

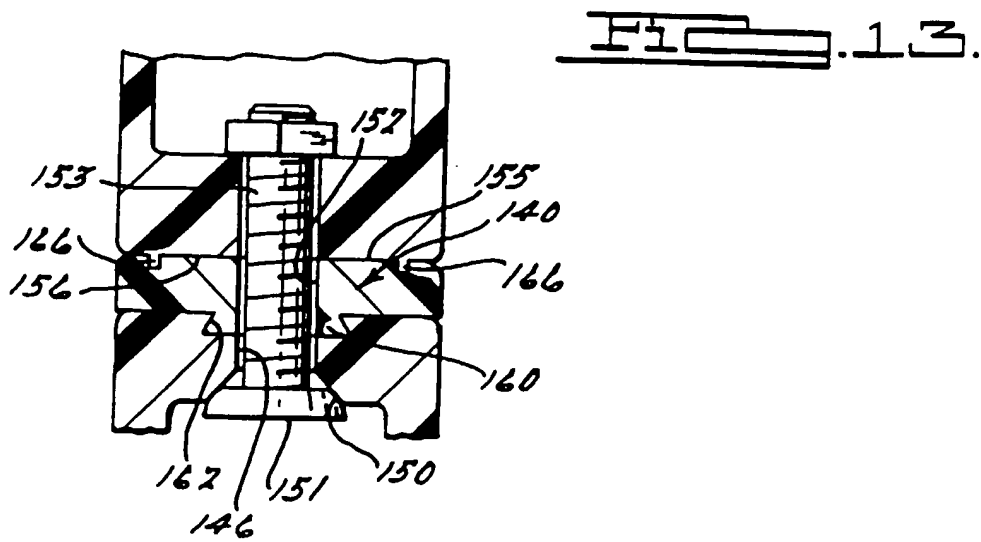
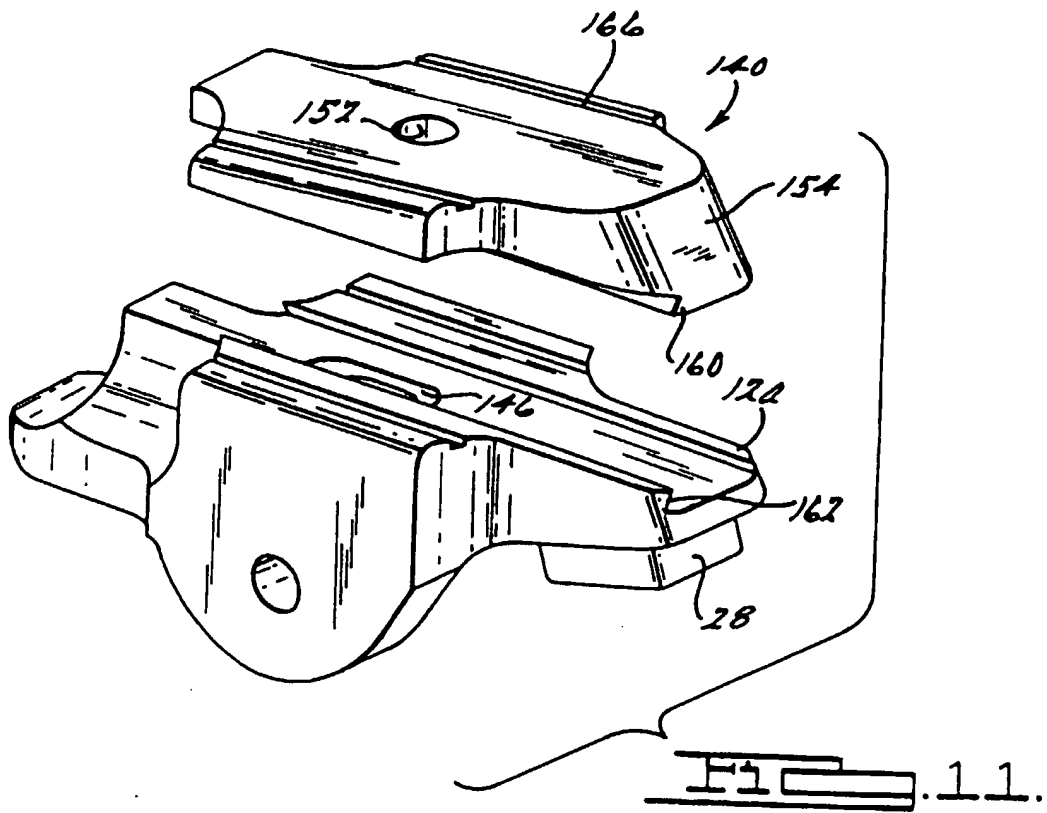
2. An artificial foot according to claim 1, wherein said toe sections (102) converge toward each other from said weight supporting section (108) of each toe section (102) to a distal tip (106) of each toe section (102).
3. An artificial foot according to claim 1 or 2, wherein each of said toe sections (102) is constructed out of a resilient biasing flexible material for providing resilient flexing of one toe section (102) with respect to the other when a weight is exerted on said weight supporting section (108) of one toe member (16).
4. An artificial foot according to one of the claims 1 to 3, further comprising an elastomeric pad (26) extending between said toe member (16) and said heel member (14) to provide resilient resistance against upward pivotal motion of said toe member (16) relative to said heel member (14).













European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 0279

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 892 554 A (ROBINSON DAVID L) 9 January 1990 (1990-01-09) * column 5, line 18 - line 28 * * column 5, line 39 - line 46; figures * ----	1-4	A61F2/66
A	US 2 475 373 A (CATRANIS) 5 July 1949 (1949-07-05) * figures 1-4 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			A61F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 8 July 1999	Examiner Sánchez y Sánchez, J
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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EPO FORM 1503 03/82 (P4/C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 99 11 0279

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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08-07-1999

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